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SURFACE HARDENING TREATMENT METHOD FOR A DEEP HOLE IN A METAL PART IN A VACUUM FURNACE

[Shinkuro ni okeru buhin shinko no hyomenkoukashorihoho]

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[Claim(s)] /*

[Claim 1] A surface hardening treatment method for a deep hole of a metal part utilizing a metallic surface treating device which controls the inner atmosphere of a furnace such as vacuum furnace, comprising a step of supplying treatment gas to a deep hole of metal part or the like which is a treatment target, a step of exhausting the gas in the furnace so as to maintain the inside of the furnace at the prescribed atmospheric pressure, and a step of generating forced convex flows of treatment gas supplied into the deep hole while maintaining the contact between the treatment gas and the inside wall of the hole under the required conditions so that the bottom area of the deep hole can be subjected to uniform gas decomposition, permeation and dispersion treatment.

[Claim 2] The surface hardening treatment method for a deep hole of a metal part according to Claim 1, wherein the aforementioned surface treatment is carburization, carbonitriding, soft nitriding, or gas-nitriding processing carried out to the surface of a metallic material.

[Claim 3] The surface hardening treatment method for a deep hole of a metal part according to Claim 1 or 2, wherein the shape of the aforementioned deep hole is an irregular shape, such as a straight hole, a bent hole, a non-penetrating hole, a penetrating hole, a manifold, and the like.

* Claim and paragraph numbers correspond to those in the foreign text.

[Detailed explanation of this invention]

[0001] [Field of the Invention]

This invention relates to a surface hardening treatment method for a deep hole of a metal part and is particularly associated with a method that carries out a surface hardening treatment for a deep hole of a metal part in a vacuum furnace.

[0002] [Description of the Prior Art]

When performing a surface hardening treatment to an inner hole of steel material during a conventional manufacturing process, if the aspect ratio (aspect ratio = depth of hole/diameter of hole) of an inner hole is relatively large, it is impossible to provide necessary hardening effects to the inner end part of the hole.

[0003] [Problem(s) to be Solved by the Invention]

Since the conventional furnace uses air or salt bath as a heat carrier, it is necessary to reprocess waste gas and waste salts. Moreover, high temperature oxidization is such a serious problem as to require manual operations. Thereby, this invention solves these problems.

[0004] [Means for Solving the Problem]

This invention provides a surface hardening method for a vacuum furnace. Although it is costly, a vacuum furnace providing high reproducibility is easily automated for mass production. According to this invention, a metal part, a gas transport pipe, and a fixing instrument are washed and dried first, then put in a heated space in

a vacuum furnace and positioned at appropriate locations. Furthermore, the heating space in the vacuum furnace is depressurized and heated to a treatment temperature. Thus, treatment gas is continuously supplied into a deep hole through a transport pipe at a pressure slightly higher than the pressure in the heating space at an appropriate flow rate. Then, since the vacuum space is maintained at a state of a prescribed low pressure by a vacuum pump, the treatment gas is naturally exhausted forcefully from the inner wall of the hole to the outside of the hole while being decomposed at the same time and permeating toward the hole wall to be diffused. In addition, an adequate duration is provided for allowing a sufficient depth of carburization. Lastly, treatments, such as cooling, are carried out to the metal part to which a carburizing treatment or a nitrocarburizing treatment is performed for obtaining a required hardened layer. The treatment method based on this invention, which can be applied for commercial use, provides drastically improved effectiveness.

[0005] [Embodiment of the Invention]

This invention solves the problem with the gas flows in the deep hole of a metal part when gas for carburization, nitriding, soft nitriding, carbonitriding, etc., is put in the deep hole of a metal part through a pipe in a vacuum furnace so as to perform carburization, nitriding, soft nitriding, or carbonitriding treatment by forced convection of the gas. With the method based on this

invention, the surface hardening process, such as carburization, nitriding, soft nitriding, carbonitriding, etc., can be performed effectively in all kinds of configurations of the hole, such as a non-penetration hole, a penetration hole, a bent hole (including branched inner holes), etc.

[0006] In order to provide the technical aspect of this invention more clearly, a concrete carburization example is described below. A metal part 90 having one non-penetration hole (JIS SCM415, outer diameter = Φ16 x 12L, inner diameter = Φ3 x 100L), a gas transport pipe 40 and a fixing instrument 30 are cleaned and dried and then installed in the prescribed positions in the heating space 20 within a vacuum furnace 10. Furthermore, the heating space 20 is depressurized by vacuuming through a gas exhaust port 11 using a vacuuming pump and then heated to a treatment temperature (950 - 1,000 °C). Furthermore, treatment gas (acetylene gas) is continuously supplied to the deep hole of the metal part 90 through the transport pipe 40 under a slightly higher pressure than the pressure of the heating space at a suitable flow rate (0.2l/min). Then, the pressure in the heating space 20 is supplemented to 5 - 6 torr through the gas supplementing port 12 by operating an "ON/OFF" control valve. Since the vacuum space 20 is maintained at a prescribed low-pressure state by vacuuming the gas using a vacuum pump, the treatment gas is forcibly discharged from the inside wall of the hole to the outside of the hole while being decomposed at the same time in the hole,

carburized and then diffused toward the hole wall. Once the process thereof is stabilized in this sequence, the temperature is maintained for an adequate duration (about 15 - 30 min) so as to obtain sufficient carburization depth. Finally, the metal part 90 which has been carburized is reheated to 860 °C and then cooled to form a required hardened layer. According to the result of hardening analysis, the hardened layer at each section of internal surface was higher than the hardened layer formed on the external surface and provided uniform and sufficient hardening depth. The relation between the maximum hardened depth and the carburization time corresponds to the diffusion principle, and thus the longer the carburation time, the more uniform depth was provided for deep-hole hardening.

[0007] [Effect of the Invention]

The method based on this invention applies a vacuum-heat treatment technique for supplying treatment gas into the inner hole of a metal part through a transport pipe so that the treatment gas is subjected to forcible convection flows by the low pressure of vacuumed space, and as a result, the surface hardening process, such as carburization, nitriding, soft nitriding, carbonitriding, etc., can be performed with the treatment gas at an appropriate temperature for a straight hole (including penetration holes and non-penetration holes), a bent hole, and a manifold, providing uniform and sufficient hardened depth. Moreover, this invention is highly reproducible and easily automated.

[Brief Description of the Drawings]

[Figure 1] A cross-sectional view explaining the process for carrying out the surface hardening treatment to the parts having non-penetrating holes.

[Figure 2] A cross-sectional view explaining the process for carrying out the surface hardening treatment to the parts having penetrating holes.

[Figure 3] A cross-sectional view explaining the process for carrying out the surface hardening treatment to the parts having bent holes.

[Description of Notations]

(10) Vacuum furnace

(11) Gas exhaust port

(12) Gas supplementing port

(20) Heating space

(30) Fixing apparatus

(40) Gas transport pipe

(50) Plug

(60) High temperature resistant airtight material

(90) Parts

Figure 1

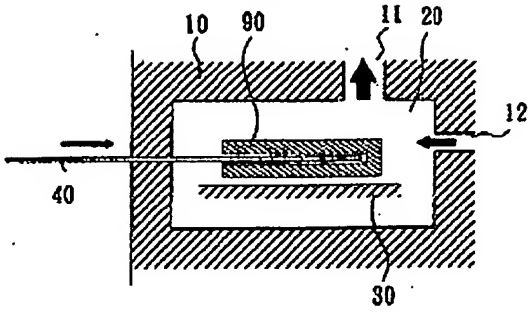

Figure 2

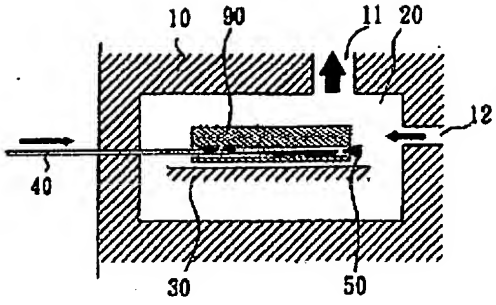

Figure 3